51707-IC-1-2005-1-CZ-ERASMUS-IPUC-3

# VOLTAGE CONTROL AND ENERGY LOSSES

Daniel Hlubeň


## ABSTRACT

*This paper entitled "Voltage control and energy losses" deals with the problem of the losses in the transmission system in the case of voltage control by control of reactive power of a generator.*


## 1 INTRODUCTION

The main goal of each operator, who is operating a transmission system, is the operation of a network with minimal losses. There are several possibilities, how to optimize electric energy losses in a transmission system.

In this article is described voltage control based on reactive power in transmission system in order to show the point, in which energy losses are the lowest.

## 2 BASICS

The transmission system of the Slovak Republic can be seen on the following simplified picture.

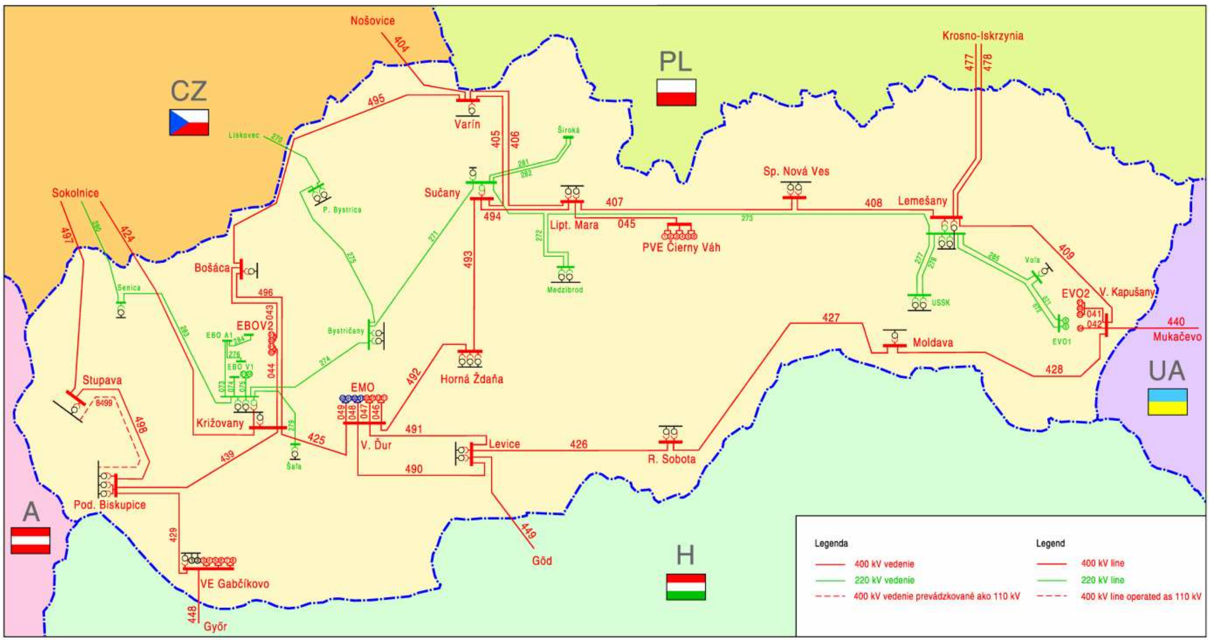


Fig. 1 The transmission system of the Slovak Republic

In my model the transmission system of the Slovak Republic is simulated. The voltage in control node is regulated by generator and the main goal is to find a value of reactive power, at which the voltage is in required range, but with lowest losses.

For this case was selected a node, in which the generator with the following parameters is placed:

$P_{min} = 20$ MW

Pmax = 110 MW
Plom = 100 MW
Qlom = -37 MVAr
Q2min = -40 MVAr
Q1mi = -25 MVAr
Q1max = 35 MVAr
Q2max = 80 MVAr

These parameters define the range, in which it is possible to operate the generator. Parameters of the generator are shown in the following figure.

The simulation is made for 3 cases:

1. Active power of generator equals 20 MW
   Range of reactive power: -40 ÷ 80 MVAr
2. Active power of generator equals 100 MW
   Range of reactive power: -37 MVAr ÷ Q1lom.
3. Active power of generator equals 110 MW
   Range of reactive power: -25 ÷ 35 MVAr

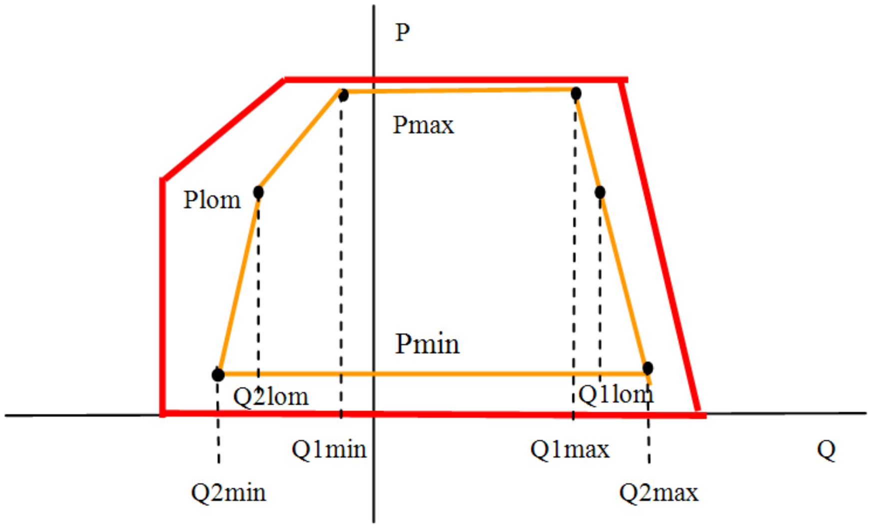


Fig. 1 Operational chart of the generator

In the following figure (fig. 2) is shown figure 1 with the description of the possible cases:

- Active power
  - o Generation
- Reactive power
  - o Generation
  - o Consumption

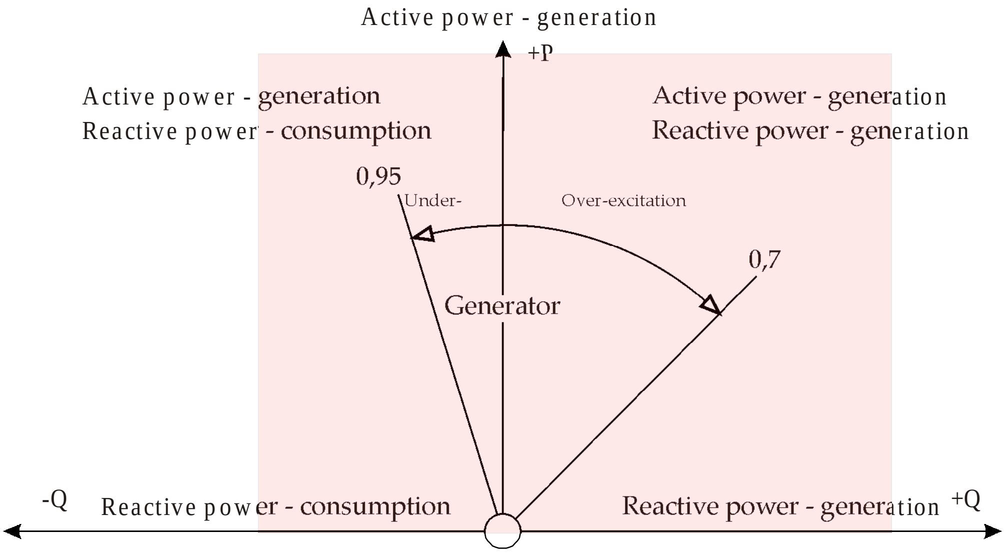


Fig 2. Operational diagram of the generator [2]

## 3 Results

In the following figure can be seen results of these simulations. In this figure are 3 dashed lines and 3 solid lines.

The dashed line defines dependency of energy losses in windings of transformers and lines on reactive power generated by the generator.

The solid line defines dependency of voltage in the control node on reactive power of the generator.

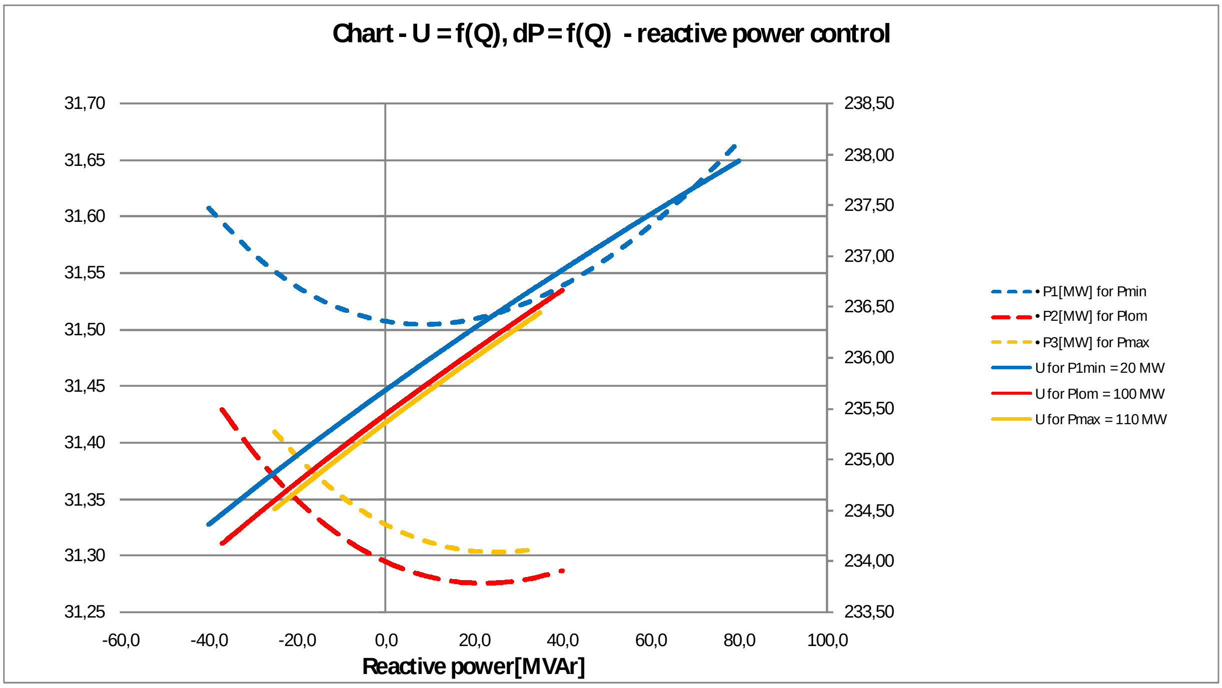


Fig 3. Voltage and losses dependency on reactive power in the regulation node

Table 1: Results of calculations

| | $P_{min}$ | $P_{lom}$ | $P_{max}$ |
|---|---|---|---|
| $dP_{min}$ [MW] (losses) | 31.5 | 31.3 | 31.3 |
| Q [MVAr] for $dP_{min}$ | 8.0 | 24.6 | 23.0 |
| $U_{node}$ [kV] for $dP_{min}$ | 235.9 | 236.2 | 236.1 |
| $dP_{max}$ [MW] | 31.7 | 31.4 | 31.4 |
| dP [MW] if Q = 0 MVAr | 31.5 | 31.3 | 31.3 |
| $U_{min}$ [kV] for $Q_{min/lom/max}$ | 234.4 | 234.2 | 234.5 |
| $U_{max}$ [kV] for $Q^{min/lom/max}$ | 237.9 | 236.7 | 236.5 |
| U [kV] for Q = 0 MVAr | 235.7 | 235.4 | 235.4 |

## 4 *Conclusion*

This model was built for voltage regulation in one node at the same time. But, the transmission system is a more complicated system and therefore it is necessary to develop other methods for optimal real-time voltage control.

The main goal of this article was to show dependencies of losses and voltages in case of voltage control based on reactive power.

## 5 *REFERENCES*

[1] Kolcun M., Chladný V., Mešter M., Cimbala R., Tkáč J., Hvizdoš M., Rusnák J.: Power plants, Košice 2006, pp. 111-112. (in Slovak), ISBN 80-8073-704-5

[2] Kolcun M., Griger V., Beňa Ľ., Rusnák J.: Electric Power System Operation, Košice 2007, pp. 149, 185, ISBN 978-80-8073-837-2

Author address:
Ing. Daniel Hlubeň
Department of Electric Power Engineering
Technical University of Košice
Mäsiarska 74
040 01 Košice, Slovak Republic
E-mail: daniel.hluben@tuke.sk
Tel: +421 / 55 / 602 355
Fax: +421 / 55 / 602 3552

This work was supported by Scientific Grant Agency of the Ministry of Education of Slovak Republic and the Slovak Academy of Sciences under the project VEGA No. 1/4072/07.

This work was supported by the Slovak Research and Development Agency under the contract No. APVV-0385-07.